

## Three New Species of Zoantharia from California

CHARLES E. CUTRESS and WILLIS E. PEQUEGNAT<sup>1</sup>

PREVIOUS TO THE DISCOVERY of the species to be described in this paper, 20 species of Zoantharia belonging to 4 genera were known from the eastern Pacific Ocean. Nine of the species were described from the Gulf of California by Carlgren (1951). With the additional species described by Verrill (1866, 1869) from Central America and one described from Panama by Le Conte (1851), there are 15 species of Zoantharia known from the warm waters of the Gulf of Panama and Gulf of California. Four species have been described from the coasts of Chile and Juan Fernandez, one by McMurrich (1904) and three by Carlgren (1898, 1920). Between this region and Panama virtually nothing is known of the zoantharian fauna. North of the Gulf of California to the southern coast of Alaska there is known but a single zoanthid, the species being described by Wood (1958).

### THE ZOANTHARIA OF THE EASTERN PACIFIC OCEAN

- Epizoanthus californicum* Carlgren, 1951, p. 436, text fig. 82, a-d, pl. 14, fig. 7. La Paz, Baja California.
- *crassum* Verrill, 1869, p. 498. San Salvador.
- *elongatum* Verrill, 1869, p. 497. Peru and Pearl Islands.
- *gabrielii* Carlgren, 1951, p. 438, pl. 14, fig. 6. Espiritu Island, Gabriel Bay, Baja California.
- *humile* Verrill, 1869, p. 498. Panama.
- *patagonicum* Carlgren, 1898, p. 38, fig. 1. S. 40° 14' W. 61° 23'. McMurrich, 1904, p. 296, pl. 19, figs. 85, 86. Calbuco, Chile. Carlgren, 1927, p. 94, text fig. 62. South of Falkland Islands.
- *scotinus* Wood, 1958, p. 707. Puget Sound, Washington.

*Palythoa complanata* Carlgren, 1951, p. 438, text figs. 82, e, f, pl. 14, fig. 9. Puerto Escondido, Baja California.

—— *ignota* Carlgren, 1951, p. 440, text figs. 83, c, d, pl. 14, fig. 12. Angeles Bay, Baja California.

—— *insignis* Carlgren, 1951, p. 441, text figs. 84, a-c, pl. 14, fig. 13. Coronado Island, Baja California.

—— *pazi* Carlgren, 1951, p. 442, text fig. 84, d, pl. 14, fig. 14. La Paz, Baja California.

—— *praelonga* Carlgren, 1951, p. 439, text figs. 82, g, h, pl. 14, fig. 10. Gabriel Bay, Baja California.

—— *rickettsi* Carlgren, 1951, p. 440, text figs. 83, a, b, pl. 14, fig. 11. Tiburón Island, Baja California.

*Parazoanthus elongatum* McMurrich, 1904, p. 298, pl. 19, figs. 87-89. Calbuco, Chile.

—— *fuegiensis* Carlgren, 1898, p. 39, fig. 6. Dawson Island, Strait of Magellan.

—— *juanfernandez* Carlgren, 1920, p. 148, text fig. 3, pl. 6, fig. 3. Juan Fernandez.

*Zoanthus confertum* (Verrill). *Mammillifera conferta* Verrill, 1869, p. 497. San Salvador.

—— *danae* Le Conte. *Zoantha danae* Le Conte, 1851, p. 320. Panama. *Mammillifera danae*, Verrill, 1869, p. 496. Pearl Islands. *Zoanthus danae*, Verrill, 1866, p. 329. Panama. Carlgren, 1951, p. 443, text figs. 84, e-h. Escondido, Coronado, Concepcion Bay, Baja California.

—— *depressum* Carlgren, 1951, p. 444, text fig. 84, i. Cape San Lucas, Baja California.

—— *nitidum* (Verrill). *Mammillifera nitida* Verrill, 1869, p. 497. San Salvador.

The three species of *Parazoanthus* known until now from the eastern Pacific are all from the southern end of South America. The new fourth species, *P. lucificum*, in addition to being the first reported from the northeast Pacific Ocean, also is the first reported instance of a member of the genus occurring regularly on a

<sup>1</sup> Smithsonian Institution and Department of Zoology, Pomona College, Claremont, California. Manuscript received January 29, 1959.

gorgonian and along with *Epizoanthus induratum* furnishes the first cases of bioluminescence in the order. The new species *Epizoanthus leptoderma* and *E. induratum* are the seventh and eighth of the genus to be reported from the eastern Pacific and the fourth and fifth from the area of Lower California and California.

The specimens of *Parazoanthus lucificum*, *Epizoanthus leptoderma*, and *E. induratum* herein described are from material collected in conjunction with an ecological survey, being conducted by the junior author, of several shallow water shale reefs off the coast of Corona del Mar, California.

The finding of three new zoantharians in subtidal water in the same area attests to the scantiness of our knowledge of the subtidal fauna of the comparatively intensely studied coast of California. More specifically, the collection of these new zoanthids by SCUBA diving at depths of 25 to 100 feet points to a possible existence at these depths of a fauna, at least in part, unlike that of either the littoral or deep water.

#### Family PARAZOANTHIDAE

##### *Parazoanthus* Haddon and Shackleton, 1891

*Parazoanthus* Haddon and Shackleton, 1891, p. 653. Type species by original designation: *Palythoa axinellae* Schmidt, 1862, pp. 61, 62, pl. 6, figs. 2, 3. Gender: neuter.

Parazoanthidae with a diffuse marginal sphincter muscle in the entoderm. Scapus and coenenchyme incrusting with foreign material. Ectoderm continuous. Mesogloea with an encircling sinus as well as ectodermal canals, lacunae, and cell islets. Polyps usually colonial and connected by bandlike or incrusting coenenchyme. Dioecious.

The diagnosis of the genus as it is given here is essentially that of Haddon and Shackleton.

##### *Parazoanthus lucificum* n. sp.

Figs. 1-3

TYPE MATERIAL: Holotype, U.S. Nat. Mus. Cat. No. 50975, one colony of 200 to 300 polyps. From off Corona del Mar, California, at a depth of 75 feet. Collected by Willis E. Pequegnat, May 5, 1957. Colony incrusting a

dead gorgonian which was attached to a shale reef.

Paratype, U.S. Nat. Mus. Cat. No. 50976, one colony of 300 to 400 polyps. From 1 mile south of Corona del Mar, California, at a depth of 85 feet. Collected by Willis E. Pequegnat, April 25, 1958. Colony incrusting a dead gorgonian which was attached to a shale reef.

DIAGNOSIS: Colony large, consisting of numerous moderately crowded polyps. Coenenchyme thin and incrusting. Scapus thin-walled. Surface of the ectoderm sparsely incrusting with fine sand and shell. Ridges of the scapulus to 17 in number, indistinct in contracted polyps but distinct in expanded ones. Tentacles and mesenteries to 30 in number. Marginal sphincter muscle in the entoderm weak. Mesogloea with an extensive encircling sinus and few cell islets. Holotrichs absent. The species grows upon the gorgonian *Muricea californica*, is brilliantly bioluminescent and secretes copious quantities of

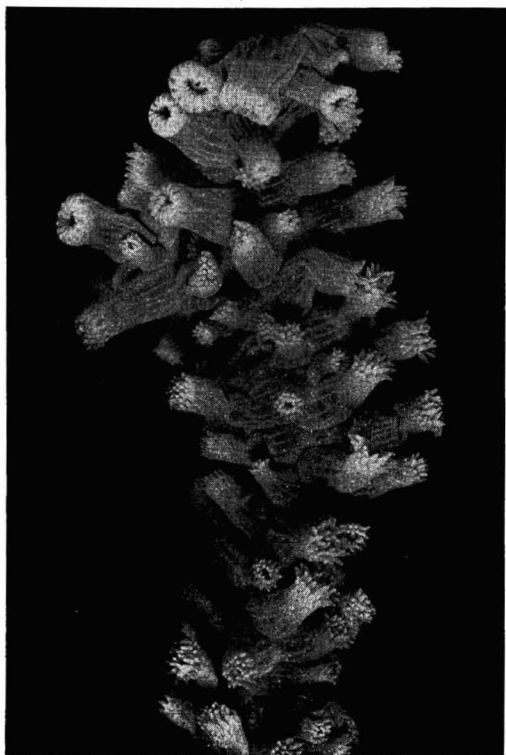


FIG. 1. *Parazoanthus lucificum*. A portion of the paratype.  $\times 1.5$ .

thick sticky slime upon stimulation or when removed from the water.

**DESCRIPTION:** *Size.* In life the largest polyps are 15 mm. long and 3.5 mm. in diameter. In the preserved semiexpanded condition the largest polyps of the holotype are about 4 mm. long and 2.5 mm. in diameter. The holotype colony almost completely covers the numerous branches of a 20 cm. gorgonian.

*External Aspects.* *P. lucificum* occurs at depths of 40 to 90 feet and is found on about 5 per cent of the *Muricea californica* in the Corona del Mar area. Whole colony brilliantly bioluminescent and secreting copious quantities of slime. Coenenchyme thin and incrusting, for the most part completely investing the branches of the gorgonian. Polyps numerous, moderately crowded, not arranged in a definite pattern. Scapus thin-walled, allowing the insertions of the mesenteries to show through. Ridges of the scapulus numbering to 17, indistinct in contracted polyps but distinct in expanded ones. On some of the well-expanded polyps the ridges of the scapulus resemble incrustated marginal vesicles. Between each ridge (just below each outer tentacle) there is a distinct V-shaped area devoid of incrustation. Coenenchyme and scapus surface sparsely incrustated with very fine sand, shell, occasional sponge spicules and foraminifers. Tentacles arranged in two cycles, moderately long, to 30 in number. Color of living specimens is bright yellow with a distinct orange ring around the mouth which extends into the actinopharynx and along the macrocnemes near the gonads.

*Sphincter.* In the entoderm, weak, made up of 15 to 18 low simple plaits, diffuse (Fig. 2).

*Mesenteries.* To 30 in number. In the 15 polyps examined the following numbers of mesenteries were observed: (25) 8, (27) 3, (28) 3, (30) 1. The polyp with 30 mesenteries had 17 macrocnemes and 13 microcnemes. The filaments are attached throughout their length to the macrocnemes and extend about three-fourths of the distance from the actinopharynx to the base. The scanty gonads are borne on the macrocnemes just below the actinopharynx. Retractor muscles of the macrocnemes very weak, diffuse (Fig. 3). Microcnemes scarcely extending above the column entoderm. The polyps of the holotype are female and those of the para-

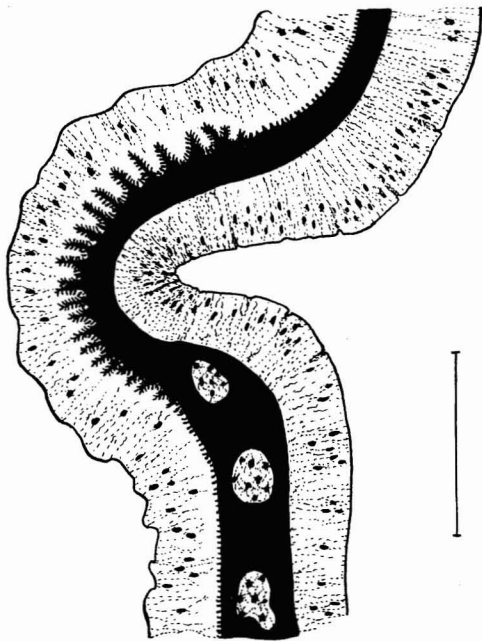


FIG. 2. Transverse section of the marginal sphincter muscle of *Parazoanthus lucificum*. Scale = .10 mm.

type, male. The gonads are ripe during June, July, and August. The larvae are retained within the body until they are well developed and are commonly observable in the lumens of the tentacles. The larva is of the zoanthella type.

*Actinopharynx.* Longitudinally corrugated. Siphonoglyph shallow but distinct. Hyposulcus indistinct, only slightly shorter than the siphonoglyph. Ectoderm without mucous or eosinophilic gland cells.

*Mesogloea.* With an extensive encircling sinus which is lined with cells similar to those of the ectoderm, with lacunae which do not contain cells, and with few cell islets. Containing very little of the incrusting material.

*Ectoderm.* Continuous, about one half the thickness of the mesogloea and containing most of the sparse incrusting material. With no mucous cells but on the surface and in some parts of the encircling sinus with a diffusely distributed nonparticulate material (probably the slime) which stains like mucus with hematoxylin.

*Entoderm.* Without zooxanthellae.

*Cnidom.* Spirocysts, of the tentacles, 18 to 22 by 3  $\mu$ , very numerous. Microbasic b-mastigo-

phores, of the tentacles, 18 to 22 by 3 to 4  $\mu$ , few (mostly at the tips); of the actinopharynx, 18 to 20 by 3 to 3.5  $\mu$ , few. Microbasic p-mastigophores, of the actinopharynx, 14 to 18 by 5  $\mu$ , few; of the filaments, 13 to 22 by 4.5 to 6  $\mu$ , common. No nematocysts could be found in either the ectoderm or the endoderm of the column. Holotrichs are absent.

#### DISCUSSION

Especially noteworthy among the several distinguishing features of *Parazoanthus lucificum* is its brilliant bioluminescence. E. N. Harvey (1952; 1955) gives no references to luminous Anthozoa excepting the Alcyonaria and none could be found in a rather thorough review of the literature on the Zoantharia. From this we in no way conclude that *P. lucificum* is unique in this respect, but we do believe that this is the first reported instance of bioluminescence for the genus *Parazoanthus*. Because of its bioluminescence we have given to the species the Latin name *lucificum*, denoting "light producer."

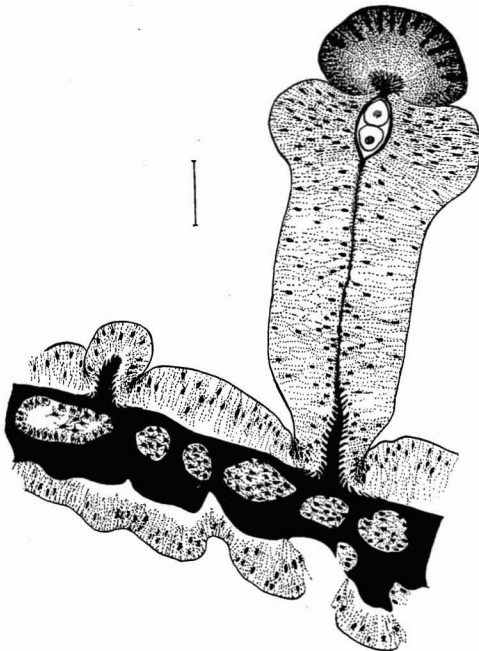


FIG. 3. Transverse section of a macro- and microcneme of *Parazoanthus lucificum*. Only the encircling sinus is shown in the column mesogloea. Section taken from mid-column. Scale = .10 mm.

The bioluminescence is restricted to the tentacles which flash both in the expanded and contracted state. The phenomenon is observed upon appropriate stimulation only. A sufficiently strong stimulus causes a large number of the polyps to light up. The glow is not steady at first but is characterized by intermittent flashes at the end of which time it continues steadily for as much as 10 seconds and then dims out. Because of the recurrent flashing, suggestive of nondirectional neural control, and negative smears for bacteria, it is our conclusion that the luminosity is intrinsic to the zoanthid. However, cells or granules that might be associated with the phenomenon were not observed.

*P. lucificum* grows upon the gorgonian *Muricea californica*. After the zoanthella larva settles on a living *M. californica* the zoanthid rapidly and entirely replaces the soft parts of the gorgonian. It appears that once the zoanthid is established the gorgonian has little or no defense against further encroachment. At the approach of the zoanthid's coenenchyme the gorgonian's tissues soften and slough off leaving exposed an area of bare skeleton which soon becomes occupied by a zoanthid polyp. This process continues until the gorgonian is completely removed from its skeleton. Although two other genera of gorgonians are found off Corona del Mar, *P. lucificum* does not grow on them. *P. lucificum* has been found growing only on *Muricea californica* in spite of the fact that a second species, *M. fruticosa*, may in places grow side by side with the former. *P. lucificum* is the only known species of the genus to be regularly associated with a gorgonian.

Morphologically and anatomically *P. lucificum* is most similar to *P. dichroicum* Haddon and Shackleton, 1891, *P. gracile* (Lwowsky, 1913), and *P. tunicans* Duerden, 1900. It can, however, be distinguished from *P. dichroicum* by its yellow color, lack of dichroism, fewer mesenteries, and larger polyps. Compared to *P. gracile*, *P. lucificum* has fewer mesenteries, larger polyps, and in the mesogloea lacks the peculiar cells with crystal-like inclusions (Lwowsky, 1913; Carlgren, 1934). The difference in the number of macrocnemes between *P. lucificum* and *P. tunicans* (to 17 in the former; to 16 in the latter) is too slight to be of diagnostic value. While

there is a difference in the zoogeographical distribution, host, and polyp size between the two species, probably the most important diagnostic character is the absence of holotrichous nematocysts in *P. lucificum* while they are relatively abundant in *P. tunicans*.

In summary, the distinguishing features of *P. lucificum* are its brilliant bioluminescence, sliminess, affinity for the gorgonian *Muricea californica*, lack of holotrichs, and, in most cases, its complement of mesenteries.

#### Family EPIZOANTHIDAE

##### *Epizoanthus* Gray, 1867

*Epizoanthus* Gray, 1867, p. 237. Type species by monotypy: *Duseideia? papillosa* Johnston, 1842, pp. 190, 251 (in part), text fig. 18 (not pl. 16, figs. 6, 7), = *Epizoanthus incrustatus* (Düben and Koren, 1847), p. 268. Gender: neuter.

**DIAGNOSIS:** Epizoanthidae with a single marginal sphincter muscle in the mesogloea. Scapus and coenenchyme incrustated with foreign material. Ectoderm usually continuous but may occasionally be discontinuous. Mesogloea often with cell islets and lacunae. Polyps either colonial or solitary. Coenenchyme bandlike, incrusting or greatly reduced in solitary forms. Dioecious.

##### *Epizoanthus leptoderma* n. sp.

Figs. 4–6

**TYPE MATERIAL:** Holotype, U.S. Nat. Mus. Cat. No. 50974, two portions of one colony with a total of 80 to 90 polyps. From a shale reef, depth 40 feet, Corona del Mar, California. Collected by Robert Given, August 25, 1957.

**DIAGNOSIS:** Colony large, consisting of numerous, moderately crowded, elongate polyps arising from a moderately thick, incrusting coenenchyme. Scapus thin-walled. Ectoderm of the scapus and coenenchyme moderately incrustated with sand. Ridges of the scapulus indistinct, to 18 in number, agreeing with the macrocnemes. Marginal sphincter muscle in the mesogloea, moderately strong, broad and transversely stratified. Tentacles and mesenteries to 36 in number. Mesogloea with few lacunae and cell islets but

with single elliptical cells especially in the regions of the oral disc and actinopharynx.

**DESCRIPTION:** *Size.* In the preserved semi-contracted state the polyps vary in length and diameter from 5 by 1.5 mm. to 20 by 5 mm. The largest portion of the colony is about 4 cm. in diameter at the base.

*External Aspects.* Polyps elongate, moderately crowded and arising from a moderately thick, incrusting coenenchyme. Scapus thin-walled, allowing the mesenterial insertions to show through. Surface of the scapus and coenenchyme with a moderately dense incrustation of fine black and white sand. Ridges of the scapulus to 18 in number, indistinct in contracted specimens. Tentacles of medium length, thin, numbering to 36 in large polyps. Color in life tan, with narrow, transverse, brown bands on the tentacles. Color in alcohol, scapus and coenenchyme gray, tentacles gray with one to several narrow, transverse, violet bands. The species occurs on shale reefs at depths of 15 to 45 feet. It is common on protected ledges.

*Marginal Sphincter Muscle.* In the mesogloea, moderately strong, broad and transversely stratified (Fig. 5).

*Mesenteries.* Usually agreeing in number with the tentacles. Those of the 10 largest specimens were (36) 1, (34) 1, (33) 4, (32) 2, and (30) 2. Several of the smallest specimens had 30 mesenteries. Polyps with 36 mesenteries have 18 macro- and microcnemes. Mesogloea lamina of the mesenteries thin. Retractor muscles of the macrocnemes very weak and diffuse (Fig. 6). The microcnemes scarcely extend above the column entoderm. Gonads were not apparent in the specimens examined.

*Actinopharynx.* Ectoderm with few gland cells and with olive-colored pigment granules in the basal portion. Siphonoglyph distinct, slightly longer than the indistinct hyposulcus.

*Mesogloea.* With a few small lacunae and a few cell islets but with rather numerous, single, elliptical cells especially in the regions of the oral disc and actinopharynx. The elliptical cells of the column are more numerous next to the entoderm. Mesogloea of the column about four or five times the thickness of the ectoderm, containing a little sand and an occasional sponge spicule.

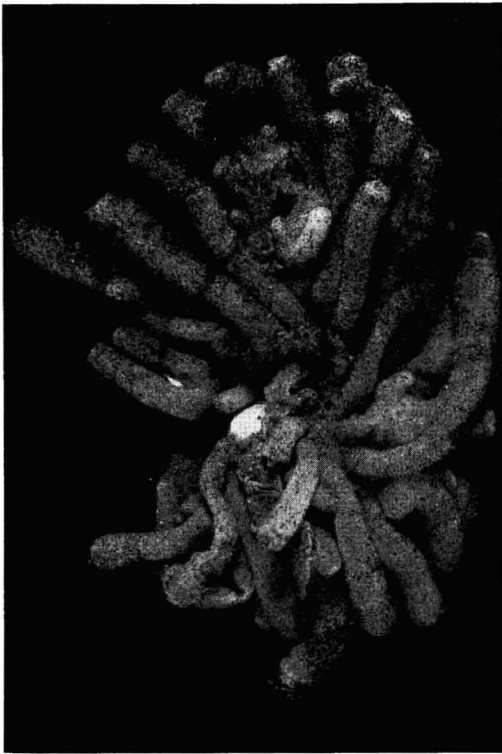


FIG. 4. *Epizoanthus leptoderma*. The largest portion of the holotype.  $\times 1.5$ .

*Ectoderm.* That of the scapus and coenenchyme containing most of the sand. That of the tentacles and oral disc with olive-colored granules at the locations of the violet markings. With little or no pigmentation in the column.

*Entoderm.* Without zooxanthellae.

*Cnidom.* Spirocyts, of the tentacles, 12 to 15 by 2.5 to 3  $\mu$ , very numerous. Basitrichs, of the tentacles, 12 by 2 to 2.5  $\mu$ , few. Microbasic b-mastigophores, of the tentacles, 12 to 15 by 3 to 3.5  $\mu$ , few; of the actinopharynx, 12 to 18 by 2 to 2.5  $\mu$ , common. Microbasic p-mastigophores, of the actinopharynx, 12 by 4.5  $\mu$ , few; of the filaments, 12 to 20 by 4.5  $\mu$ , numerous. Holotrichs, of the actinopharynx (entoderm), 37 to 40 by 12 to 15  $\mu$ , common; of the filaments, 37 to 40 by 12 to 15  $\mu$ , common. No nematocysts could be found in the column.

#### DISCUSSION

Superficially *E. leptoderma* appears to be in-

termediate between *E. gabrieli* Carlgren and *E. californicum* Carlgren. The growth form and dimensions of the *E. leptoderma* colony and polyps are essentially the same as those of *E. californicum*. The chief external difference between these two species is the thinner column wall and weaker incrustation of *E. leptoderma* (the characteristic for which this species is named). Histological examination, in addition, reveals that the marginal sphincter of *E. leptoderma* is much weaker and shorter than that of *E. californicum*. Although there is an overlap in the number of mesenteries between the two species, it is only an occasional polyp of *E. leptoderma* that will have the lesser mesenterial complement of *E. californicum*. The mesogloea, especially of the column, of the latter species is several times as thick as that of *E. leptoderma* and, furthermore, the cells of the mesogloea of *E. californicum* are larger, more numerous, and have a different distribution. The cells of the mesogloea of the column of *E. leptoderma* are concentrated near the entoderm, whereas in *E. californicum* these cells are uniformly distributed. There is close agreement in the dimen-

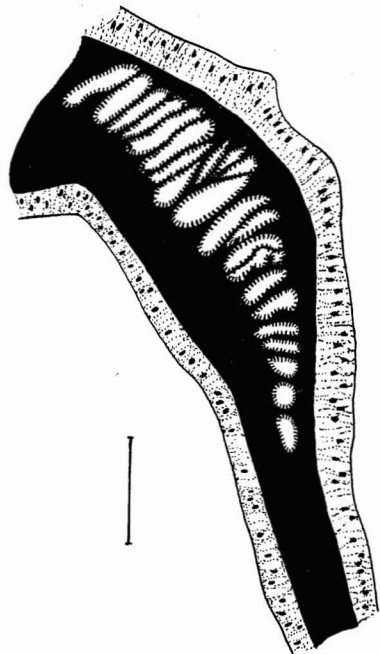


FIG. 5. Transverse section of the marginal sphincter muscle of *Epizoanthus leptoderma*. Scale = .10 mm.



sions of the nematocysts of the two species but the distribution of the kinds is slightly different.

Comparing *E. leptoderma* with *E. gabrieli*, we find that the colony and polyps of the former species are larger and the scapus and coenenchyme are thinner and more sparsely incrustated. Internally the marginal sphincter muscle of *E. leptoderma*, although slightly weaker, resembles that of *E. gabrieli*, but only in its upper part. Whereas the sphincter of *E. leptoderma* is short, that of *E. gabrieli* tapers gradually to a long tail which becomes alveolar (Fig. 7).

One point of similarity that at first seemed important was the tendency of the cells of the mesogloea to be concentrated near the entoderm. Carlgren, 1951, stresses this feature as a characteristic of *E. gabrieli*. However, in the sections of a second polyp of *E. gabrieli* we found that these same cells are rather evenly distributed in the mesogloea. In the case of *E. leptoderma*, the concentration of cells of the mesogloea near the entoderm was rather obvious in all the polyps sectioned.

When the mesenteries of the two species are compared in sections taken from a point half way between the end of the actinopharynx and the pedal disc, it is found that the microcnemes are about one half the length of the macrocnemes in *E. gabrieli* while in *E. leptoderma* the free edges of the microcnemes scarcely extend beyond the margin of the column entoderm. In the former species, near the column, the mesogloea lamellae of both micro- and macrocnemes are greatly thickened, a feature which Carlgren, 1951, does not mention. In contrast, the mesogloea lamellae of the mesenteries in *E. leptoderma* are weak and there is little difference in their thickness from column to free edge (compare Figs. 6 and 8). The difference in appearance of this musculature in the two species is not due to differential contraction, for sections of both contracted and expanded polyps of *E. leptoderma* were compared with those of *E. gabrieli*. As the polyps of both species had inactive gonads, the different appearance of the mesenteries could not be due to differences in this physiological state. We think the differences between the mesenteries of *E. leptoderma* and *E. gabrieli* are morphological and constant.

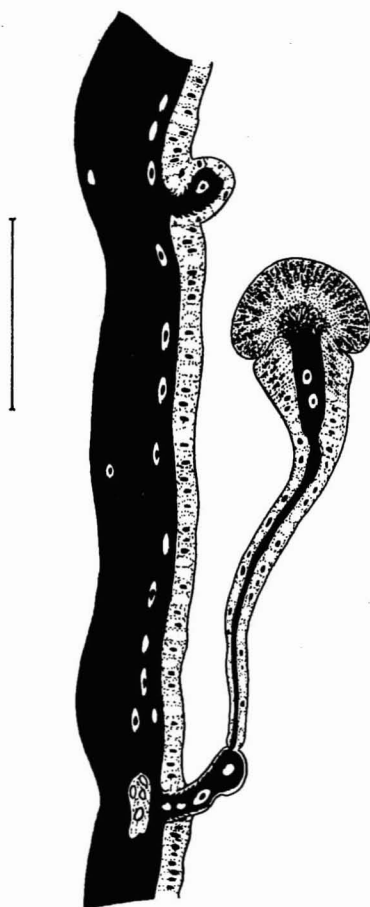


FIG. 6. Transverse section of a macro- and microcneme of *Epizoanthus leptoderma*. Shown in the column wall mesogloea are cells concentrated near the entoderm. Section taken from mid-column. Scale = .10 mm.

It seems clear to us that, although *E. leptoderma* possesses a few characters of both *E. gabrieli* and *E. californicum*, for the most part these similarities are outweighed by the unique characters of each species, and in our estimation the three are distinct species.

*Epizoanthus induratum* n. sp.

Figs. 7-9

TYPE MATERIAL: Holotype, U.S. Nat. Mus. Cat. No. 51054, one colony of about 60 polyps. From Corona del Mar, California, 1 mile S. E. of Newport Harbor entrance and one half mile

off shore at a depth of 75 feet. Collected by Willis E. Pequegnat, November 6, 1958. Colony incrusting the base and lower portions of a *Muricea californica* which was attached to a shale reef.

Paratype, U.S. Nat. Mus. Cat. No. 51055, one colony of about 20 polyps. From Corona del Mar, California, one half mile off shore at a depth of 75 feet. Collected by Willis E. Pequegnat, November 6, 1958. Colony incrusting a piece of shale.

Paratype, U.S. Nat. Mus. Cat. No. 51058, several fragments of a colony with a total of about 100 polyps. From  $1\frac{1}{3}$  miles S. E. of Corona del Mar, California, at a depth of 75 feet. Collected by Willis E. Pequegnat, November 26, 1958. Colony incrusting a piece of shale.

DIAGNOSIS: Colonies large, consisting of numerous, rather widely separated polyps. Coenenchyme moderately thick, incrusting, greatly expanded and heavily impregnated with fine sand. Scapus thick-walled, heavily impregnated

with fine sand. Ridges of the scapulus to 22 in number, indistinct in contracted polyps but prominent in expanded ones. Tentacles and mesenteries to 38 in number. Marginal sphincter muscle in the mesogloea moderately strong. Mesogloea thick, with few single cells except in the actinopharynx, few lacunae, and few or no cell islets. The species grows principally upon shale but may occasionally be found on the gorgonian *Muricea californica*, is bioluminescent and pale salmon in color.

DESCRIPTION: *Size*. Of large expanded living polyps, length 7 mm., diameter of oral disc 6 mm., length of tentacles 7 mm. In a preserved, semicontracted state the polyps vary in length and diameter from 1 by 1.5 mm. to 5 by 4 mm. The holotype colony covers the base (about 5 by 8 cm.) of a *Muricea californica* and extends along several of the main branches of the gorgonian for a distance of about 8 cm.

*External Aspects*. *Epizoanthus induratum* occurs on shale and the gorgonian *Muricea californica* at 75 feet or more. It is an abundant species in the Corona del Mar area and has been observed to form colonies 10 square meters or more on the shale bottom. The species is firm, rough to the touch and bioluminescent. Coenenchyme incrusting, moderately thick, very much expanded, and heavily incrusting with fine silicious sand. Polyps numerous, those of colonies growing upon shale rather widely separated one from the other but those of colonies growing upon gorgonians closer together. Polyps randomly arranged and unequal in size (small ones interspersed with large ones). Some of the polyps of the preserved specimens are high and free while others, presumably more contracted, scarcely extend above the surrounding coenenchyme (Fig. 7). Scapus thick-walled, heavily incrusting with fine silicious sand. Ridges of the scapulus prominent in expanded polyps but indistinct in contracted ones, to 22 in number. Scapulus devoid of incrustation except for the ridges which are heavily incrusting. Tentacles long, to 38 in number. Color in life pale salmon, tentacles unmarked, mouth edged with white and immediately peripheral to this a ring of yellow.

*Sphincter*. Moderately strong, lying in the outer portion of the mesogloea, broadest in its

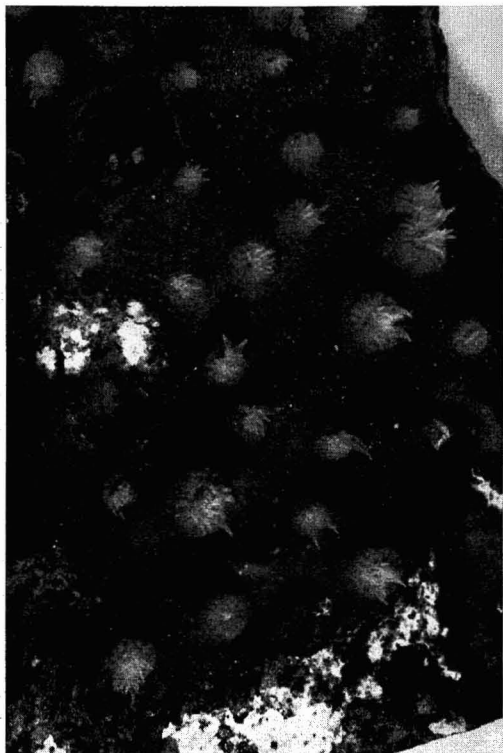


FIG. 7. *Epizoanthus induratum*. Paratype.  $\times 1.5$ .



upper part and abruptly tapered below, for the greater part openly stratified and with large interstices and thick trabeculae (Fig. 8). Some of the interstices containing large cells with eosinophilic granules.

*Mesenteries.* To 38 in number. In six of the largest polyps examined the following numbers of mesenteries were observed,  $22 + 16 = 38$  (1),  $20 + 14 = 34$  (1),  $19 + 13 = 32$  (1), and  $18 + 12 = 30$  (3). Retractor muscles of the macrocnemes very weak, diffuse. Below the actinopharynx the macrocnemes are borne on high, longitudinal ridges projecting from the body wall into the coelenteron (Fig. 9). These ridges are thickenings in the column wall involving both the mesogloea and entoderm. All polyps sectioned were male and bore ripe testes.

*Actinopharynx.* Smooth. Ectoderm with numerous acidophilic and few mucous gland cells. Siphonoglyph prominent, considerably longer than the actinopharynx. Hyposulcus indistinct, same length as actinopharynx.

*Mesogloea.* Of the scapus, 30 to 40 times the thickness of the entoderm, with a few scattered cells, few lacunae, and few or no cell islets; densely packed with sand throughout even into the ridges of the lower column upon which the macrocnemes are borne. Of the actinopharynx (siphonoglyph excepted), with rather numerous, large cells having a vacuolated cytoplasm. Of the oral disc, without cells.

*Ectoderm.* Of the column, continuous, about one tenth the thickness of the mesogloea; containing sand, few mucous cells and numerous acidophilic gland cells. Of the oral disc, with few or no nematocysts but with numerous acidophilic gland cells especially around the mouth where the epithelium is unusually high. Among the acidophilic gland cells are cells (20 by 6 to 7  $\mu$ ) containing nonstaining granules (.75 to 1.5  $\mu$ ).

*Entoderm.* Without zooxanthellae. Of the column, with numerous acidophilic gland cells. Of the actinopharynx and adjacent portions of macrocnemes, with large cells, similar to those of the ectoderm, containing large nonstaining granules.

*Cnidom.* Spirocysts, of the tentacles, 10 to 12 by 2  $\mu$ , pyriform, very numerous. Microbasic b-mastigophores, of the tentacles, 15 by 2.5 to

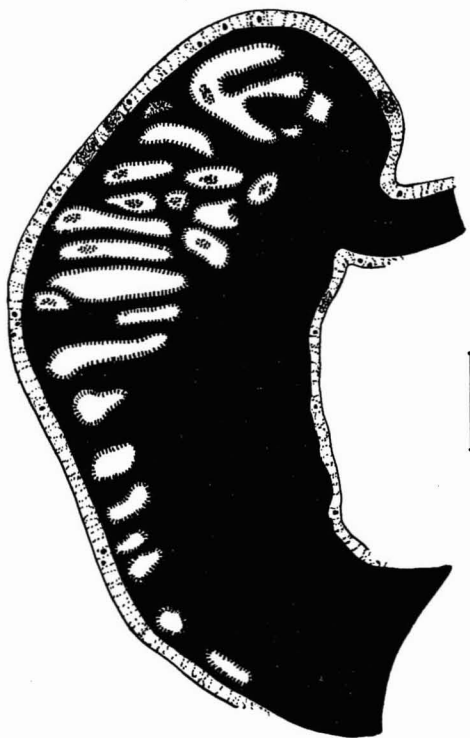


FIG. 8. Transverse section of the marginal sphincter muscle of *Epizoanthus induratum*. Scale = .10 mm.

3  $\mu$ , few; of the actinopharynx, 18 to 22 by 3  $\mu$ , numerous. Microbasic p-mastigophores, of the filaments, 15 to 19 by 5  $\mu$ , numerous. Holotrichs, of the tentacles, 25 to 30 by 8 to 10  $\mu$ , numerous; of the column (ectoderm), 20 to 28 by 8 to 10  $\mu$ , common; of the actinopharynx, 30 by 10  $\mu$ , few; of the filaments, 30 to 37 by 10 to 11  $\mu$ , numerous.

#### DISCUSSION

*Epizoanthus induratum* is a common species in the Corona del Mar area at depths of 75 feet and more. It has been observed to grow upon shale and the gorgonian *Muricea californica* but is more frequently found on the former substrate. Those colonies on *Muricea* become established on the living gorgonian and encroach upon it in the same manner as has been described for *Parazoanthus lucificum*. In reference to the firmness of this new *Epizoanthus*, caused by the dense incrustation of sand, the Latin ad-

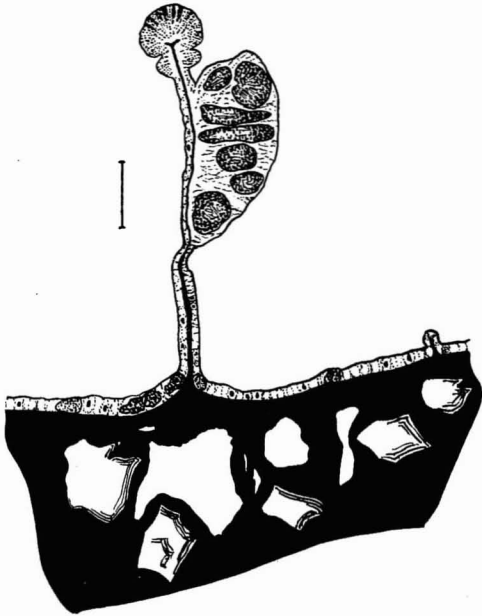


FIG. 9. Transverse section of a macro- and microcneme of *Epizoanthus induratum*. The dense incrustation of the ectoderm and mesogloea has been largely omitted. Section taken from mid-column. Scale = .10 mm.

jective *induratum* (hardened) has been selected for the name of the species.

With respect to bioluminescence, *E. induratum* is not so bright as *Parazoanthus lucificum*. Whereas the source of luminescence in the latter species could not be determined, in the case of *E. induratum* it is very likely associated with the cells with large nonstaining granules that occur in the ectoderm around the mouth and in the entoderm of the actinopharynx and adjacent portions of the macrocnemes. There is no direct evidence that these cells are luminous; nevertheless, their distribution in the polyp and the resemblance they bear to the luminous cells of *Pelagia* (Harvey, 1952, fig. 47) strongly suggest they have to do with the light production observed in the living zoanthid.

Superficially the growth form of *E. induratum* which occurs on *Muricea* very closely resembles *Parazoanthus lucificum*. However, unlike *P. lucificum*, *E. induratum* is not slimy and only infrequently grows upon gorgonians. Among the species of *Epizoanthus*, *E. induratum* resembles only *E. papillosum* of the North Atlantic Ocean

and then only in certain anatomical features. For example, the number of mesenteries is the same in both species; the sphincter muscle in *E. induratum*, although slightly weaker, is very much like that of *E. papillosum*, and in contraction the sphincter imparts a truncate appearance to the distal ends of the polyps of both species. Other features the two species have in common are few cells and lacunae in the mesogloea, heavy incrustation of sand, and prominent ridges on the scapulus. The two species differ chiefly in growth form and geographical distribution. Although it is conceivable that the same species might occur in both the North Atlantic and North Pacific oceans, the predominant habit of *E. papillosum* to form carcenoecia or occasionally small, unattached colonies strongly suggest we have to do with two species. In addition, the nonagreement in size and distribution of nematocysts, the inconspicuous microcnemes, its bioluminescence, and the peculiar aggregation of acidophilic gland cells around the mouth of *E. induratum* leaves little doubt that the species is new.

Undoubtedly occasioned by the scanty material available to him, Carlgren, 1951, gives but a brief description of *Epizoanthus gabrieli*. On the basis of his description alone we could not fully compare *E. leptoderma* with *E. gabrieli* and for this reason felt justified in further dissecting and sectioning a part of what remains of the holotype of *E. gabrieli*. Through this investigation we have obtained a little more information which we would like to offer here for incorporation with Carlgren's description and thus more fully describe and illustrate his species.

#### *Epizoanthus gabrieli* Carlgren

Figs. 10, 11

*Epizoanthus gabrieli* Carlgren, 1951, p. 438, pl. 14, fig. 6.

MATERIAL EXAMINED: Holotype, U.S. Nat. Mus. Cat. No. 49463, one colony of five polyps. From Gabriel Bay, Espíritu Santo Island, Baja California. Collected by E. F. Ricketts, April 12, 1940.

Carlgren's description of *E. gabrieli* has been found on re-examination to be accurate in the main. However, instead of "incrusted with

grains of sand occupying the main part of the mesogloea," we find that the incrustation is largely in the very thick ectoderm and is only sparsely present in the mesogloea. This slight discrepancy is likely due, in Carlgren's case, to the incrusting particles being carried into the mesogloea by a dull knife while sectioning. Although the polyps are small, they have a very thick column wall. The mesogloea is about five times as thick as the entoderm, and in turn the ectoderm is about two times as thick as the mesogloea.

The description of the sphincter muscle given by Carlgren, "strong, broad, transversely stratified," refers to the upper part only. He fails to mention that the sphincter tapers gradually to

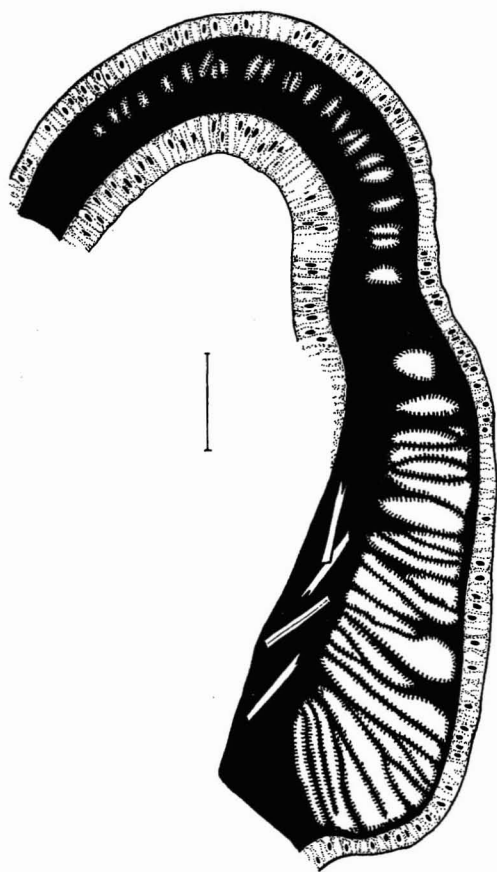


FIG. 10. Transverse section of the marginal sphincter muscle of *Epizoanthus gabrieli*. The higher epithelium is entoderm. Scale = .10 mm.

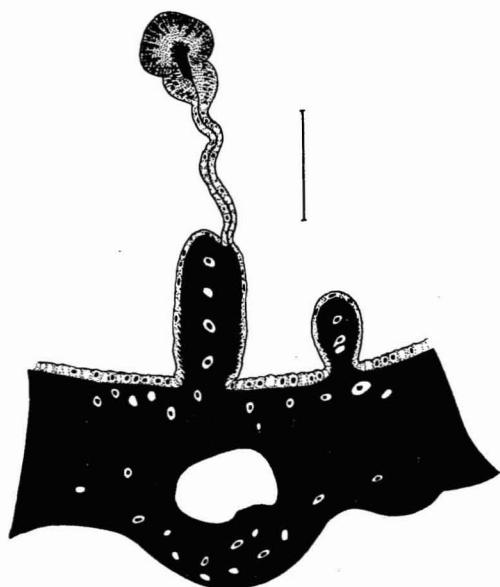


FIG. 11. Transverse section of a macro- and microcneme of *Epizoanthus gabrieli*. The large space in the column mesogloea is an artifact. Section taken from mid-column. Scale = .10 mm.

a long tail which is more alveolar than stratified (Fig. 10).

The mesenteries of the polyp cut by Carlgren number 30, but a second and slightly smaller one sectioned by us had 28. The mesogloecal lamellae of the mesenteries of *E. gabrieli* are greatly thickened near their attachment to the column wall (Fig. 11). In the case of the macrocnemes, the thickened portion extends about half way to the filamental edge. The microcnemes, on the other hand, because they do not bear filaments, are entirely thick. In section, the microcnemes are about half the length of the thickened portion of the macrocnemes. The mesogloea of the thickened parts of the mesenteries has much the same appearance as that of the column. The retractor muscles of the mesenteries are very weak.

#### REFERENCES

- CARLGREN, OSKAR H. 1898. Zoantharien. Ergebnisse der Hamburger Magalhaensischen Sammelreise 1892, 1893. 1(4): 1-47, 1 pl., figs. 1-18. Hamburg.

- . 1920. Actiniaria und Zoantharia von Juan Fernandez und der Osterinsel. IN *The Natural History of Juan Fernandez and Easter Island*. Carl Skottsberg, ed. Vol. 3, pp. 145–160, text figs. 1–18, pl. 6, figs. 1–4.
- . 1927. Actiniaria and Zoantharia. IN *Further Zoological Results of the Swedish Antarctic Expedition 1901–1903, under the Direction of Dr. Otto Nordenskjöld*. Vol. 2, No. 3. Pp. 1–102, text figs. 1–62.
- . 1934. Über einige Ostasiatische Zoantharien. *Ark. Zool.* 28A(5): 1–11, text figs. 1–6.
- . 1951. The actinian fauna of the Gulf of California. *Proc. U. S. Nat. Mus.* 101 (3282): 415–449, text figs. 78–84, pl. 14, figs. 1–14.
- DÜBEN, M. W., and J. KOREN. 1847. Om nogle norske Actinier. *Forh. Skand. Naturf. Møte*. P. 266.
- DUERDEN, JAMES E. 1900. Jamaican Actiniaria. Part 2: Stichodactylinae and Zoantheae. *Sci. Trans. R. Dublin Soc.* Vol. 7, ser. 2, part 6. Pp. 133–208, pls. 10–15.
- GRAY, JOHN E. 1867. Notes on Zoanthinae, with the descriptions of some new genera. *Proc. Zool. Soc. Lond.* 15: 233–240, 1 text fig.
- HADDON, ALFRED C., and ALICE M. SHACKLETON. 1891. A revision of the British Actiniae, Part 2. The Zoantheae. *Sci. Trans. R. Dublin Soc.* Vol. 4, ser. 2, part 12. Pp. 609–672, pls. 58–60.
- HARVEY, E. NEWTON. 1952. *Bioluminescence*. xvi + 649 pp., 187 figs. Academic Press Inc., New York.
- . 1955. Survey of luminous organisms: Problems and prospects. IN *Luminescence of Biological Systems*. Frank H. Johnson, ed. Pp. 1–24, 1 table. A.A.A.S., Washington.
- JOHNSTON, GEORGE. 1842. *A History of British Sponges and Lithophytes*. Vol. XII. 264 pp., 23 text figs., 25 pls. Edinburgh.
- LE CONTE, JOHN L. 1851. Zoological notes. *Proc. Acad. Nat. Sci. Philad.* 5: 316–320.
- LWOWSKY, FRITZ F. 1913. Revision der Gattung *Sidisia* Gray (*Epizoanthus* auct.). *Zool. Jb., Abt. f. Syst.* Vol. 34, parts 5, 6. Pp. 557–614, text figs. A-H and J-M, pl. 19, figs. 1–8, 1 map.
- McMURRICH, JAMES P. 1904. The Actiniae of the Plate Collection. *Zool. Jb., Suppl. Bd. 6* (Fauna Chilensis Bd. 3) heft 2. Pp. 215–306, pls. 14–19.
- SCHMIDT, OSCAR. 1862. *Die Spongien des Adriatischen Meeres*. vi + 88 pp., 7 pls. Verlag von Wilhelm Engelmann, Leipzig.
- VERRILL, ADDISON E. 1866. On the polyps and corals of Panama, with descriptions of new species. *Proc. Boston Soc. Nat. Hist.* 10: 323–333.
- . 1869. Review of the corals and polyps of the west coast of America. *Trans. Conn. Acad. Arts Sci.* Vol. 1, part 2, no. 6. Pp. 377–558, pls. 4–10.
- WOOD, RICHARD L. 1958. Identification and microanatomical study of a new species of *Epizoanthus* (Zoanthidea). *Abstr. Diss.* 18 (2): 707–708.